

# **METHOD FOR PREDICTING AND ESTIMATING COORDINATES OF A TOUCH PANEL**

## **BACKGROUND OF THE INVENTION**

### **1. Field of the Invention**

5        The present invention relates to a method for estimating coordinates, and more particularly to a method for predicting and estimating coordinates of a touch panel.

### **2. Description of Related Art**

      A conventional touch panel usually comprises an indium tin oxide glass (ITO glass) and an indium tin oxide film (ITO film) that are combined to form a glass panel. By touching the glass panel and via a conductor, a printed circuit board (PCB) with an integrated circuit (IC), an image is shown on a screen. According to the sensing modes, the touch panels are approximately divided into three types, such as 10      15      20      25      30      35      40      45      50      55      60      65      70      75      80      85      90      95      100      105      110      115      120      125      130      135      140      145      150      155      160      165      170      175      180      185      190      195      200      205      210      215      220      225      230      235      240      245      250      255      260      265      270      275      280      285      290      295      300      305      310      315      320      325      330      335      340      345      350      355      360      365      370      375      380      385      390      395      400      405      410      415      420      425      430      435      440      445      450      455      460      465      470      475      480      485      490      495      500      505      510      515      520      525      530      535      540      545      550      555      560      565      570      575      580      585      590      595      600      605      610      615      620      625      630      635      640      645      650      655      660      665      670      675      680      685      690      695      700      705      710      715      720      725      730      735      740      745      750      755      760      765      770      775      780      785      790      795      800      805      810      815      820      825      830      835      840      845      850      855      860      865      870      875      880      885      890      895      900      905      910      915      920      925      930      935      940      945      950      955      960      965      970      975      980      985      990      995      1000      1005      1010      1015      1020      1025      1030      1035      1040      1045      1050      1055      1060      1065 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calculating where the ITO film is pressed.

All the conventional touch panels detect the X-coordinates and the Y-coordinates on the touch panel. However, the coordinates value detected by the conventional touch panel usually includes somewhat 5 miscellaneous. Consequently, a difference is certainly contained.

The present invention has arisen to mitigate and/or obviate the disadvantages of the conventional method for estimating coordinates of a touch panel.

#### SUMMARY OF THE INVENTION

10 The main objective of the present invention is to provide an improved method for predicting and estimating coordinates of a touch panel.

To achieve the objective, the method provides a filter to the touch panel. The filter predicts the antecedent and estimating 15 X-coordinate and Y-coordinate by predict technique to calculate a sampling cycle, a predicted X-coordinate and a predicted Y-coordinate. And then the filter estimates the estimating X-coordinate and Y-coordinate by using the predicted X-coordinate, the predicted Y-coordinate, the present measurement X-coordinate and the present 20 measurement Y-coordinate and relying on the Orthogonal Principle. Consequently, the estimating X-coordinate and the Y-coordinate are more accurate than that of the conventional touch panel and has a good relationship with adjacent coordinates.

Further benefits and advantages of the present invention will become apparent after a careful reading of the detailed description with appropriate reference to the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a flow chart of a method for estimating coordinates of a touch panel in accordance with the present invention; and

Fig. 2 is a graph for comparing the measurement position to the estimation position and the true position of the touch panel.

#### DETAILED DESCRIPTION OF THE INVENTION

10 Referring to the drawings and initially to Figs. 1 and 2, for being used in a method for estimating coordinates of a touch panel in accordance with the present invention, the touch panel (1) is 5-wired and comprises an A/D converter (2) electrically connected to the touch panel (1), a microprocessor (3) electrically connected to the A/D converter (2) and a Kalman filter (4) algorithm embedded in the microprocessor (3). The touch point on the touch panel (1) has an X-coordinate and a Y-coordinate each transmitting an analogy voltage to the A/D converter (2) that transform the two analogy voltages into two 12 bits digital signals. The two 12 bits digital signals are transmitted to the microprocessor (3) for locating the X-coordinate and the Y-coordinate on the touch panel (1). The Kalman filter (4) predicts the antecedent and estimating X-coordinate and Y-coordinate by predict technique to calculate a sampling cycle, a predicted

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X-coordinate and a predicted Y-coordinate. And then the filter estimates the estimating X-coordinate and Y-coordinate by using the predicted X-coordinate, the predicted Y-coordinate, the present measurement X-coordinate and the present measurement Y-coordinate  
 5 and relying on the Orthogonal Principle. Consequently, the estimating X-coordinate and the Y-coordinate are more accurate than that of the conventional touch panel and has a good relationship with adjacent coordinates.

The method includes the following formulas.  
 10 To suppose the X-coordinate and the Y-coordinate on the touch panel (1) is the Xdata and Ydata that have a linear formula as follow.  

$$Z(k) = \theta_m(k) + v_m(k), \quad \theta_m(k) = \begin{bmatrix} X_{data}(k) \\ Y_{data}(k) \end{bmatrix}$$
  
 Z(k) is the measured  $X_{data}(k)$  and  $Y_{data}(k)$ ,  $v_m(k)$  is the average value  $\varepsilon_m$  and the variation value  $\delta_m$  is from the white Gauss  
 15 miscellaneous signals.

A. The Predicting formula:

$$\hat{\theta}_m(k|k-1) = A * \hat{\theta}_m(k-1|k-1)$$

$$P(k|k-1) = A^T P(k-1|k-1) A + \omega_m(k-1)$$

20 wherein  $A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ ,  $P(0|0) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$  and  $\omega_m(0) = \begin{bmatrix} qm & 0 \\ 0 & qm \end{bmatrix}$ , P(k) is the predicting factor and  $\omega_m(k)$  is the predicting miscellaneous signal Variation value.

B. The estimating formula:

$$K(k) = P(k|k-1)C^T [CP(k|k-1)C^T + vm(k)]^{-1}$$

$$\hat{\theta}m(k|k) = A\hat{\theta}(k|k-1) + K(k)[Z(k) - C\hat{\theta}m(k|k-1)]$$

$$P(k|k) = [I - K(k)C]P(k|k-1)$$

wherein  $vm(k) = \begin{bmatrix} \delta m & 0 \\ 0 & \delta m \end{bmatrix}$ ,  $C=1$ ,  $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$  and  $K(k)$  is the estimating

5 factor.

The  $Z$  and  $\hat{\theta}(k|k-1)$  in the above formula are combined to estimate the final X-coordinate and the final Y-coordinate values

$$\hat{Z}(k) = \hat{\theta}m(k|k).$$

With reference to Fig. 2, a Matlab software is used to simulate a  
10 sine-wave on the touch panel. The formula for setting the X-coordinate and the Y-coordinate of the sine-wave is followed.

X-coordinate is set from 0 to 6.28 and the interval between two X-coordinates is 0.1 such that the group of X-coordinates and Y-coordinates has 62 pieces.

15  $X=0:0.1:2\times3.14;$

$Y=\sin(x);$

Setting parameters:  $Pk(1)=1$ ,  $wm=0.1$  and  $vm=0.1$ ;  $Pk$  indicates the predict factor,  $wm$  indicates estimate error and  $vm$  indicates the miscellaneous signal from the variation value.

20 The signal includes miscellaneous signals when the microprocessor (3) explains the positions Xdata and Ydata of X-coordinate and Y-coordinate. The  $vx$  is miscellaneous signal of X-coordinate and the  $vy$  if the miscellaneous signal of Y-coordinate.

The group of the X-coordinate and the Y-coordinate includes 62 pieces.

for i=1:1:62

The miscellaneous signal of X-coordinate is supposed as  $\pm 0.2$  and the miscellaneous signal of Y-coordinate is supposed as  $\pm 0.2$ .

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5 vx(i)=(-1)^i×rand(1)/5;
vy(i)=(-1)^i×rand(1)/5;
Xdata(i)=x(i)+vx(i);
Ydata(i)=y(i)+vy(i);
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10 The Kalman filter is used to predict the Xdata and the Ydata by predict technique to calculate a sampling cycle and get a predict value Xt and Yt. The Kalman filter read the new measure value and uses the Orthogonal Principle to renew the Xdata and the Ydata respectively into Xtt and Ytt. The SNR\_m indicates the error quantity of the Xdata and the Ydata. The SNR\_p indicates the error quantity of the Xt and the Ytt. The formula is now as follow, wherein the Kk(i) is the estimate factor. The Original data of X-coordinate is equal to the measure data:

15 Xtt(1)=Xdata(1) and the original data of Y-coordinate is equal to the measure data: Ytt(1)=Ydata(1). The original error between the measure data and the true data is set as zero: SNR\_m=0 and the error between the estimate data and the true data is set as zero: SNR\_p=0. The Kalman filter starts predicting at the second piece of the X-coordinate and the Y-coordinate: for i=2:1:62. The Xt is predicted from the Xdata:

20 Xt(i)=Xdata(i-1) and the Yt is predicted from the Ydata: Yt(i)=Ydata(i-1).

25 The predict factor is calculated from the previous predict factor and the

wm:  $P_k(i) = P_k(i-1) + w_m$  and the formula for calculating the estimating factor is  $K_k(i) = P_k(i) / (P_k(i) + v_m)$ . The formula for calculating the estimating X-coordinate:  $X_{tt}(i) = X_t(i) + K_k(i) \times (X_{data}(i) - X_t(i))$  and the formula for calculating the estimating Y-coordinate is:

5       $Y_{tt}(i) = Y_t(i) + K_k(i) \times (Y_{data}(i) - Y_t(i))$ . The formula for renewing the  $P_k(i)$  is:  $P_k(i) = (1 - K_k(i)) \times P_k(i)$ .

The formula for calculating the error between the measure data and the true data is:  $SNR1 = (X_{data}(i) - x(i))^2 + (Y_{data}(i) - y(i))^2$  and the formula for calculating the error between the estimate data and the true data is:  $SNR2 = (X_{tt}(i) - x(i))^2 + (Y_{tt}(i) - y(i))^2$ . The formula for calculating the sum of all of the measure errors is:  $SNR\_m = SNR\_m + SNR1$  and the formula for calculating the sum of all of the estimating errors is:

10      $SNR\_p = SNR\_p + SNR2$ .

With reference to Fig. 2, the  $X_{tt}$  and the  $Y_{tt}$  are estimated by the 15    Kalman filter (4) and closer to the sine-wave than the  $X_{data}$  and the  $Y_{data}$ . As shown in Fig. 2, the  $SNR\_p = 0.3645 < SNR\_m = 1.5687$ , the  $X_{tt}$  and the  $Y_{tt}$  has a smaller error than that of the  $X_{data}$  and the  $Y_{data}$ . Consequently, the final X-coordinate and the Y-coordinate is more accurate than that of the conventional touch panel and has a good 20    relationship with an adjacent coordinates.

Although the invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.